VENTILATION OF RAILROAD CARS.

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Almost every person who has had occasion to ride any considerable distance on railroads, especially if there are many passengers, has experienced discomfort from the imperfect ventilation of the cars. This is especially noticeable on entering a car on any of the fast or express trains which make but few stops, and the air consequently is seldom changed by opening of the doors to receive or discharge passengers. The air in such cars is very repulsive; yet the passengers have become so accustomed to breathing the foul air, or are so stupified by its influence, that they make no complaint. But to a person entering the car, passing from the pure out-door air, the stench is intolerable.

Several years ago I rode in a car from Detroit to Ypsilanti. The weather was very cold, and every window was closed. The car was crowded, every seat full, and many passengers stood in the aisle. The air became so foul that the candles "burned blue;" the candle in the rear end of the car was extinguished twice before we reached Ypsilanti, and the candle near the middle of the car went out once in the same distance. When the train stopped and the doors were opened for a few minutes, the candles burned brightly, but when the doors were closed, the candles burned more and more dimly till some of them were extinguished. The candle in the front end of the car burned more freely because a strong wind was blowing from the southwest, and some fresh air was forced into this portion of the car, enough to sustain combustion. This car had the Ruttan ventilation, but the weather being very cold, the valves in fresh-air pipes were closed because no one would endure a blast of air blowing upon them while the temperature of this air was near zero. This is the fatal defect in Ruttan ventilation in cold weather.

I have been requested by several persons to give my attention to this subject of railroad ventilation. Hon. S. S. Cobb, Commissioner of Railroads for this State, has several times called my attention to this subject. "Something must be done to secure ventilation of railroad cars; the air in most of them in cold weather is simply horrible." Urged by such men, and also urged by my desire to do something for the comfort and health of railroad passengers, I have given some attention and thought to this subject, and herewith present the results of such study.

In cars, as elsewhere, ventilation is secured by a constant influx of pure air, and a corresponding efflux of foul air. But in securing this change of air, due regard must be paid to the health and comfort of the passengers. No ventilation is good that subjects the passengers to a draught of cold air. "A blast of cold air may kill like a sword." The evil effects of such cold draughts are

often experienced in cars where the windows can be opened. A friend of mine rode in a car from Chicago to Jackson in cold weather. A lady wrapped in cloak, shawl and furs, sat by an open window through which a strong blast of cold air blew upon the other passengers. After enduring this outrage for some time, she was politely requested to suffer the window to be closed. "I prefer to have it open," said the serene fur-clad lady (?). Thus this selfish thing inflicted 250 miles of misery upon her fellow travellers. Such an outrage would be tolerated nowhere save in an American railroad car, and at the hands of one who called herself a lady! My friend was sick for two weeks in consequence of this exposure, and doubtless others suffered from the same cause.

The problem in ventilating a car is, to introduce a sufficient amount of pure air, which shall penetrate all parts of the car space without seriously disturbing any one by unpleasant and unwholesome draughts, and with as much economy of heat as can be secured. The practice of placing ventilators near the top of the car, by which much of the heated air will escape, without any adequate change of air in the body of the car, is a wasteful and inefficient system of ventilation. Open-window ventilation is open to serious objections because of draughts, and the entrance of dust and cinders. The Ruttan system is objectionable because of draughts, and too small a supply of air, from the fact that no efficient way is provided for the escape of foul air from the floor-level. We cannot force air in any quantity into a closed space, except as we provide for the escape of a corresponding quantity. The Baker system (I believe it is called) of warming cars by hot-water pipes passing beneath each seat, while excellent as a car-heater, is open to the serious objection that no ventilation or change of air is provided, not even the amount of change which is secured with a stove by the escape of the smoke and air through the stove-pipe. It will thus be seen that the ventilation of railroad cars is very imperfect.

In a car as in every closed room, the different strata of air will occupy positions according to their temperature; the warmest and lightest portion will be at the top, and the coldest and heaviest at the floor-level. The air may be chilly to one while sitting, but hot to one standing. Mr. Bush, Superintendent of the Jackson, Lansing & Saginaw Railroad, told me that while he was conductor on a passenger train he had often heard passengers complain of cold, while at the same time he was bathed in perspiration from the excessive heat. The passenger and conductor lived in air of very different temperature, because at different levels.

This waste heat at the top of the car should be utilized to warm the fresh but cold air which is brought in for purposes of ventilation; that is, *fresh air should be introduced at the top of the car, and foul air removed from the bottom of the car.*

One very important favoring condition of car ventilation is the movement of the car through the air, so that relatively to the car a very strong wind is blowing at nearly all times. If the air is calm and the train is moving 25 or 30 miles an hour, the result is the same as if a very strong wind were blowing and the car stationary. It is only in rare instances that the train is moving with the wind and at the same velocity, so that the train is becalmed by its motion. Any one can see that good ventilation is much more easily secured when a strong and steady wind is blowing than in a calm. By means of this strong wind from the motion of the train relatively to the air, a blast may be thrown into a car by a funneled tube with its mouth open *against* the wind; an exhaus-

tion of air from the car may be secured by means of funneled tubes with their mouths opening *with* the wind.

There are two systems by which air may be forced into a car by means of the motion of the car; one by means of a pump, the lever of which is attached to a car wheel so that each revolution of the wheel would cause a stroke of the piston of the pump, throwing a pump-full of air into the car; the other is by means of the inertia of the air from the relative difference in motion of the outside air and of the car. The pump system has been tried at the east, but as it is easily thrown out of working condition, and would introduce but a small amount of air unless the pump was large and cumbrous, it never came into general use.

The second system is much more simple and inexpensive, and is the one by which the problem of car ventilation will finally be solved.

There are two general systems of ventilation: one by forcing an excess of air into a room (the *plenum* plan), the excess of air being left to find its way out of the room by any chance openings; the other, where air is forcibly withdrawn from a room (the *vacuum* plan), where the air is left to find its way into the room by any cracks and openings. Both of these plans of changing the air in a room,—one by creating an artificial excess of air in the room, and the other by creating an artificial deficiency,—have had their several advocates, but they are both open to objection. By combining both systems, viz.: forcing air into a room and at the same time forcibly withdrawing air from the same room, we most effectually secure that rapid change of air which is sought in ventilation, and at the same time avoid the local draughts which are one disagreeable feature of poor ventilation.

In car ventilation it is essential to rapidly change the air by bringing in a large quantity of fresh air and by removing with equal rapidity a corresponding amount of foul air, the exchange of fresh for foul air being effected without creating sensible draughts or seriously disturbing the temperature. Ventilation is much more needed in a car than in an ordinary room, because the cubic space allotted to each passenger is usually much less than in ordinary rooms. To avoid disturbance of the temperature and to economize heat, the fresh air should be introduced at the top of the car, so that the excessively heated air at the top of the car-space may warm the fresh air so that it will be of agreeable temperature before it reaches the passengers. The foul air should be withdrawn from the floor-level, and thus a complete change of air in the car will be secured. The incoming air should never create sensible draughts, because it is a source of discomfort to which passengers will not readily submit, and because it endangers their health.

I present two plans for car ventilation, hoping they may contribute something towards securing fresher and purer air in our railway cars.

FIRST METHOD.

My first plan is a modification of the Ruttan system, and is presented because it would be very easy of application in cars constructed for Ruttan's ventilators. In the middle of the car a vertical tube 15 inches in diameter passes from the deck of the car down to the bottom of the fresh-air box within the car. The upper end of this tube is surmounted by a large revolving funnel, the mouth of which is kept constantly turned to the wind by means of a strong wind-vane attached to the back of the funnel. The lower end of the vertical tube dips lightly into a tank of water at the bottom of the fresh-air box (sunk below the

level of the car floor to prevent any drip within the car). The air is thus brought in contact with water before it enters the car, whereby all dust and cinders are arrested, and the air is moistened before entering the car. In cold weather the air will not take up much moisture, but in hot weather it will take up a sensible amount of water and become more cool and refreshing thereby. From opposite sides of the fresh-air box, near the roof of the car, a tube 12 inches in diameter proceeds to the end of the car, these tubes being so joined to the fresh-air box that they can readily revolve around their long axes. A strip along one side of the tube and embracing one-third of the circumference of the tube is made of perforated tin plate or fine wire gauze, to permit the escape of air in very fine streams. By revolving these long tubes on their axes, the perforated strip may be at the top, side, or bottom, and the air sent in one direction or the other as may best suit the wishes of passengers; in cold weather the perforated strip would be at the top, but in very hot weather it might be at the bottom.

To remove the foul air, the space beneath four seats—two on each side of the car, and about one-third the length of the car from each end—is boxed up for a foul-air box, but opening at the end into the aisle, the opening being covered with a coarse wire screen. From the bottom of each foul-air box a tube eight inches in diameter passes through the floor of the car and terminates (by recurving) in a funnel which opens in the opposite direction to that in which the car is moving. These funnels can revolve so as to always open to the rearward of the car. The rapid motion of the funnels relatively to the outside air, will cause a strong outward draught, and thus rapidly withdraw the foul air from the floor-level of the car.

The sketch, in diagram 1, of a vertical section of one side of a car will enable the reader to comprehend the plan better than any mere description.

By this method of ventilation the air when introduced is free from all dust and cinders, is evenly distributed through the car, and without any sensible draught or discomfort even to the most sensitive, while the foul air is rapidly withdrawn at the same time. The expense of introducing such a system would be very small, nor would it involve any expense after the first introduction.

SECOND METHOD.

In cars not provided with the Ruttan system a very simple and effective means of introducing an abundant supply of fresh air may be provided by utilizing the elevated space at the top of the car immediately over the aisle. The sides of this small second story of the car sometimes contain small ventilating windows, but they are inefficient even when open, and are usually closed when ventilation is most needed. This space can be put to a better use than to display stained glass and ornamental but delusive ventilators. If the main roof of the car is carried from side to side so as to close the bottom of this second story there will be a continuous gallery running the whole length of the car, some two and a half feet wide and about a foot deep. If both ends of this gallery are open to the air, a strong current of air will sweep through it when the car is in motion. If the forward end is open and the other closed, this current of air will enter the top of the car-space by any openings in the floor of this gallery. A large valve placed in each end of the gallery will regulate the amount of air passing, preventing its passage or permitting partial or free passage, according to the position of the valve. In this way the amount of air admitted into the car may be under control.

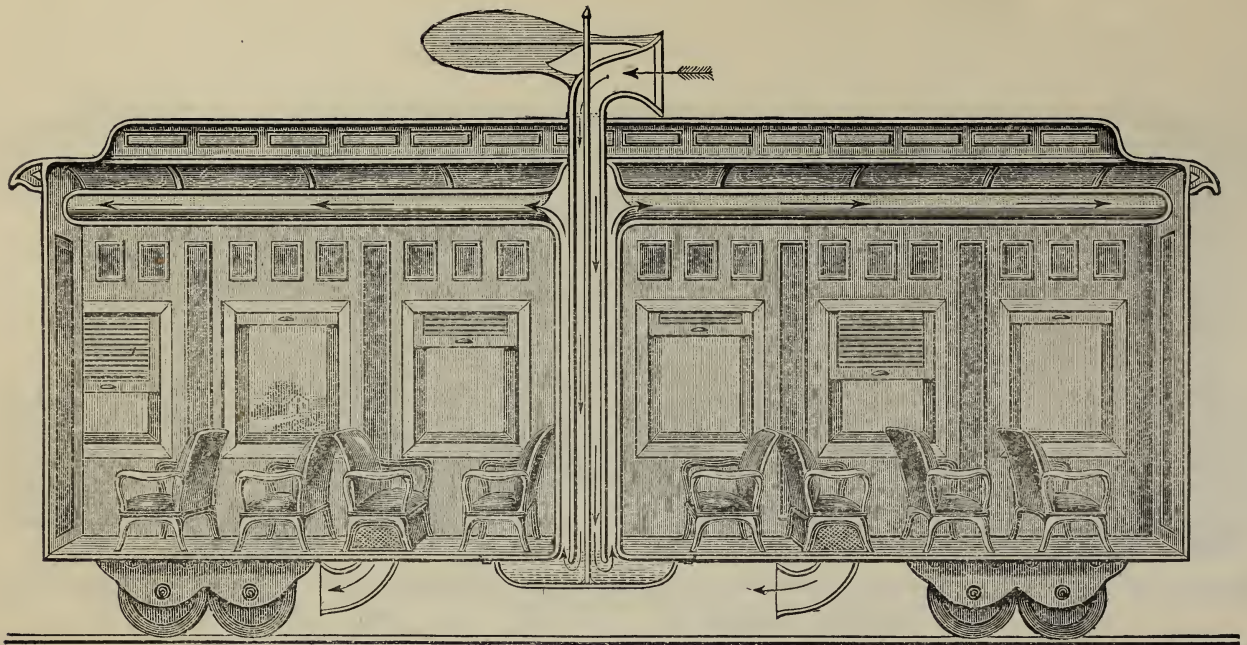

Diagram 1. Illustrating Ventilation of R. R. Car. Car Moving Toward the Right.

Designed by R. C. Kedzie. Mich. Eng. Co., Detroit. Drawn by W. S. Holdsworth.

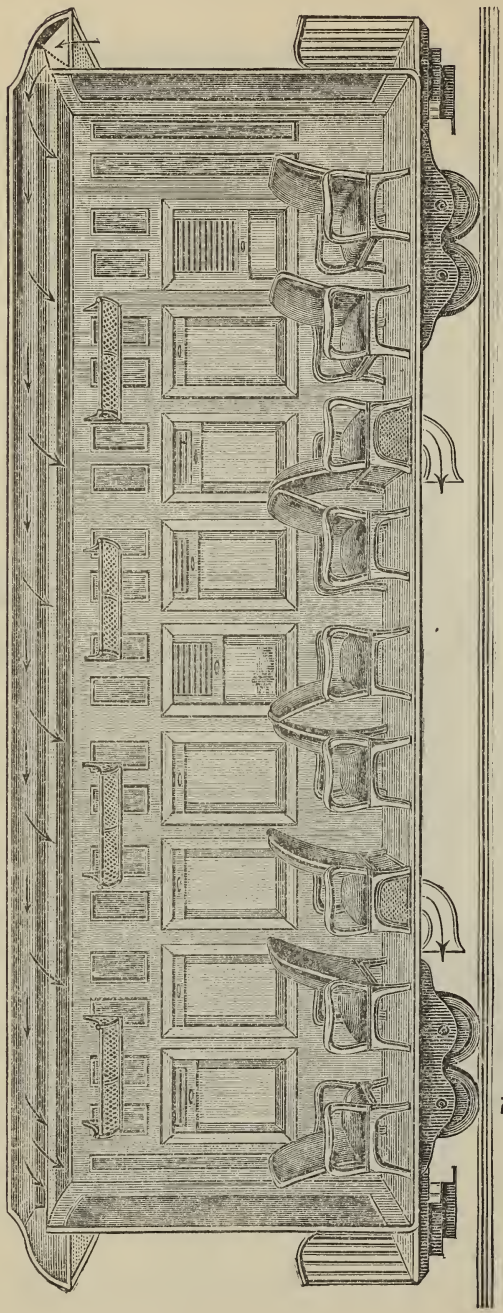

Diagram 2. Illustrating Ventilation of R. R. Car. Car Moving Toward the Right.

Designed by R. C. Kedzie. Mich. Eng. Co., Detroit. Drawn by W. S. Holdsworth.

Smoke and cinders from the locomotive may enter this gallery and be a source of discomfort to the passengers. The entrance of cinders may be prevented for the most part by placing wire screens over the external openings of the gallery. In the Winchell system the external openings are directly at the ends of the gallery, while in the Kirby system the openings are under the hood that covers the platform of the car. In this respect the Kirby system is the better for excluding both cinders and smoke. In both these systems the fresh air is admitted into the car-space by ten circular registers in the floor of the gallery, which may be opened or closed by turning the wheel of the register. The air is thus admitted in an unbroken current, which is an objectionable feature especially in cold weather. I think that far better results can be obtained by *replacing these registers by a strip of perforated tin plate,* one foot wide, and extending the whole length of the gallery. By this means the incoming fresh air is broken up into very minute streams—is *pulverized,* as it were—and so intimately mingled with the warm air at the top of the car that no sensible draught will be possible. The perforated tin plate will also sift out any cinders and dust, and be an additional safeguard against this annoyance.

The manner of ventilating by this second method is illustrated by Diagram 2, which represents a vertical section of the center of the car through its length. The air enters the ventilating gallery through wire screens beneath the hoods that cover the platforms, traverses the gallery and enters the interior of the car through the strip of perforated tin-plate, which runs the whole length of the gallery. The arrows serve to indicate the course of the air. A valve commands the entrance of air through the wire screens in the hood at each end of the car; the valve may be closed, preventing the entrance or exit of air, may be partly open, or wide open, thus regulating the amount of air passing. In the diagram the car is supposed to be rapidly moving to the right; the valve in the forward end is open, and the one at the rear closed. The foul air is withdrawn at the floor level by the foul-air ejectors opening beneath the car the same as in the first method.

This second method of ventilating a car is a modification of the Kirby system, differing from it in the larger size of the fresh air gallery, the method of admitting the fresh air into the interior of the car, and providing an adequate means of removing the foul air. I consider the improvements important, and essential to the successful working of the Kirby system, especially in very cold weather.

The methods of car-ventilation which I have recommended will act satisfactorily only when the car is in motion, and will cease to act when the car stops. It is difficult to devise any system of ventilation which will act equally well when the car is at rest and when it is in rapid motion, unless we resort to mechanical propulsion of the air. This last method would be so expensive that I have no hopes to see such a system adopted by any board of railroad directors.

Any system of car-ventilation, to work satisfactorily, must be under the exclusive control of the conductor and brakeman. The opening of the car windows at the whim of every passenger will entirely disturb the best system of ventilation, besides admitting cinders and dust. In cars, as elsewhere, this truth remains, that "one sinner destroyeth much good."

A modification of the second method would afford a third method of ventilation, as follows: the fresh air gallery is divided at its center by a vertical diaphragm passing across from side to side, impervious to air, and thus dividing the gallery into two galleries, each, half the length of the car. By leaving the

valves at both ends open, air will enter by the forward half of the gallery, and leave the car by the posterior half. By this means the air will be constantly changed; but the mass of the air in the car will not be as effectually changed as it is where the air is withdrawn at the floor level. It will not economize the heat as well as in the other methods, but will obviate the use of the foul-air ejectors in the floor as recommended in the first and second methods. It would answer very well for warm weather, but would not be as satisfactory in cold weather.

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